SEE Test Report:

SINGLE-EVENT TESTING OF THE MSK5101 HIGH CURRENT,
LOW DROPOUT VOLTAGE REGULATOR

Manufactured by MS Kennedy.

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I. Introduction

This study was undertaken to determine the single event transient (SET) susceptibility of the MSK5101 high-current, low-dropout voltage regulator from MS Kennedy (figure 1), which is a candidate for use on the Hubble Space Telescope Advanced Camera System. We are mainly interested in transient characteristics directly at the output for the Hubble ACS application (See figure 2). The output of the DUT was monitored for SETs, which were tallied, recorded and digitized on a digital storage oscilloscope for off-line analysis. The parts were irradiated with heavy ions at the Texas A&M University Cyclotron Facility.

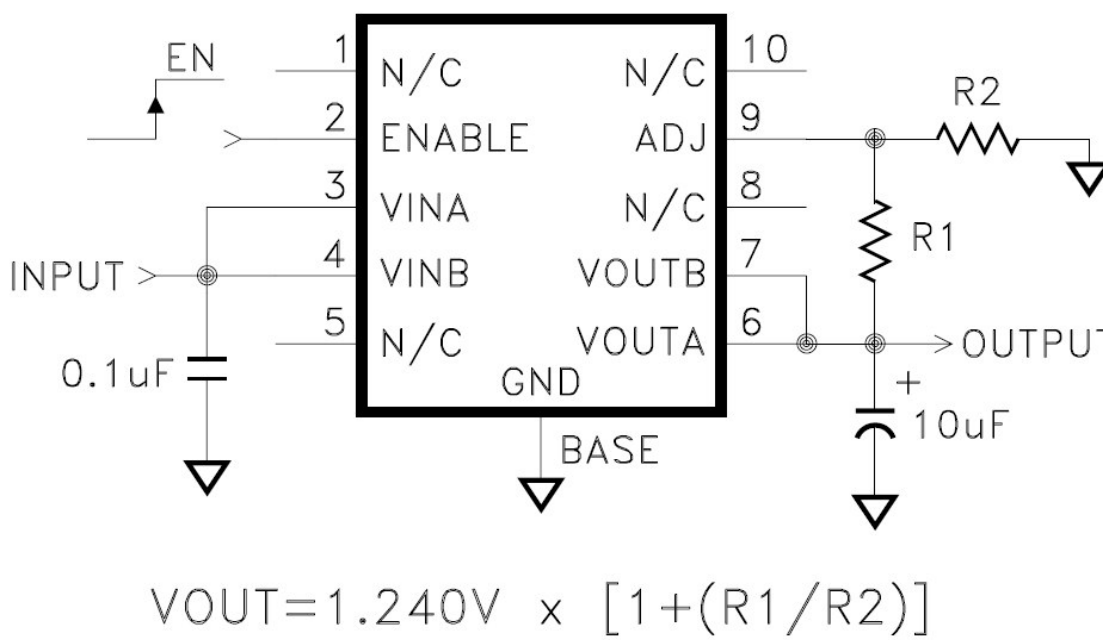

Fig. 1. Pinout and typical application for the MSK5101.

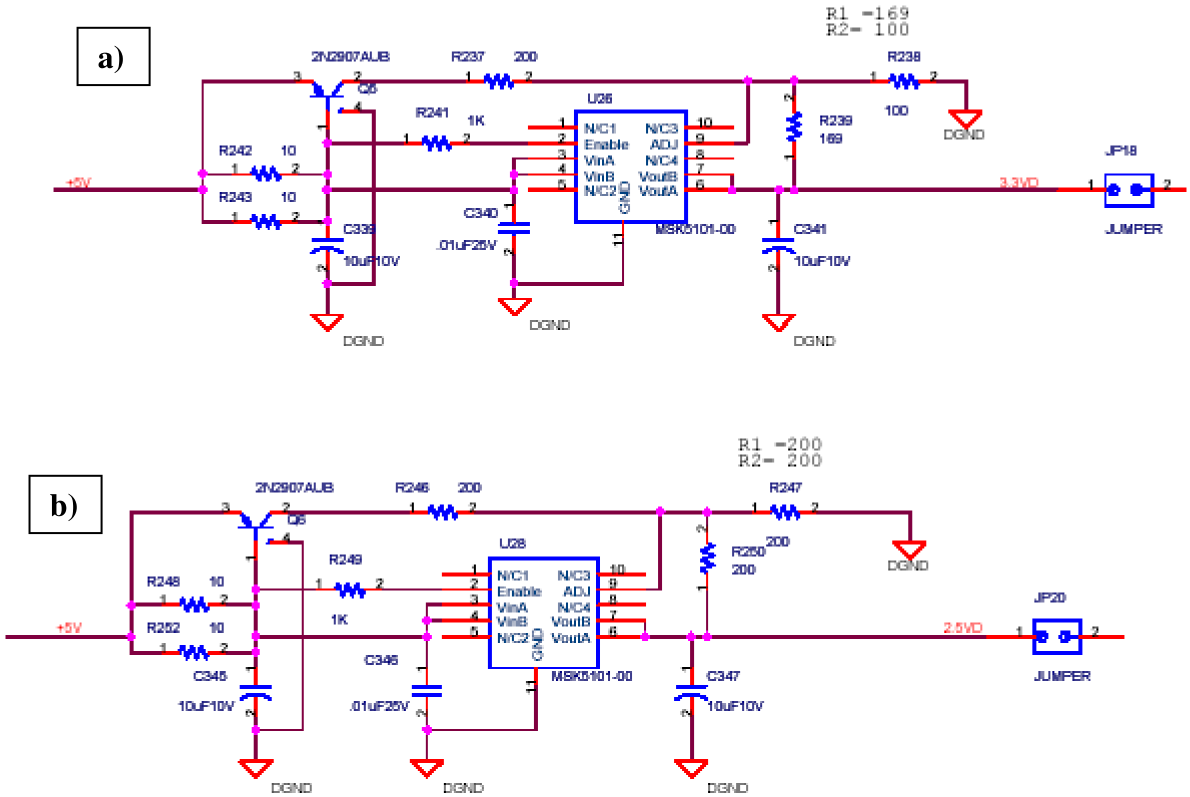

Figure 2 Applications of the MSK5101-00 in the HST ACS, a)2.5 V (this test) , b) 3.3 V.

II. Devices Tested

The sample size consists of 2 voltage regulators manufactured by MS Kennedy. The devices to be tested have a Lot/Date Code of 0739.

The device technology is bipolar and the devices are packaged in a 10-pin ceramic DIP.

III. Test Facility

Facility: Texas A&M University Cyclotron Single Event Effects Test Facility, 15 MeV/amu tune.

Flux: 5 x 10^3 to 1 x 10^5 particles/cm^2/s.

Fluence: All tests were run until at least 200 transients have been captured, until a preset fluence (2E6 particles cm^{-2}) or until destructive or functional failure has occurred.

Ions:

Table I

Ion	LET ($MeV \cdot cm^2/mg$)
Ne	2.8
Ar	7.8
Kr	28
Xe	53

IV. Test Conditions and Error Modes

The following test conditions were observed

Test Temperature: Room Temperature.
Operating Frequency: DC.
Power Supply Voltage: +5.0 V.
Output Voltage: +2.5 V and +3.3 V
Parameters of Interest: Amplitude and width of transients. Oscilloscope trigger level will initially be set to 100 mV and adjusted to the appropriate level if transients are not seen.
SEE Conditions: SETs may be both positive and negative in amplitude with widths around 1 µs or more.
Angle of Incidence: Variable

V. Test Methods

Fig. 3 shows the test setup for the operational amplifier. The setup contains a power supply for V_{dd} (5V). The outputs were connected to inputs of a digital oscilloscope with a resolution of at least 1 ns. The digital oscilloscope was set to trigger on voltage deviations from DC that are greater than +/-50 mV. After a transient was captured, it was immediately transferred to a computer for later analysis. The computer controled both the oscilloscope and power supply.

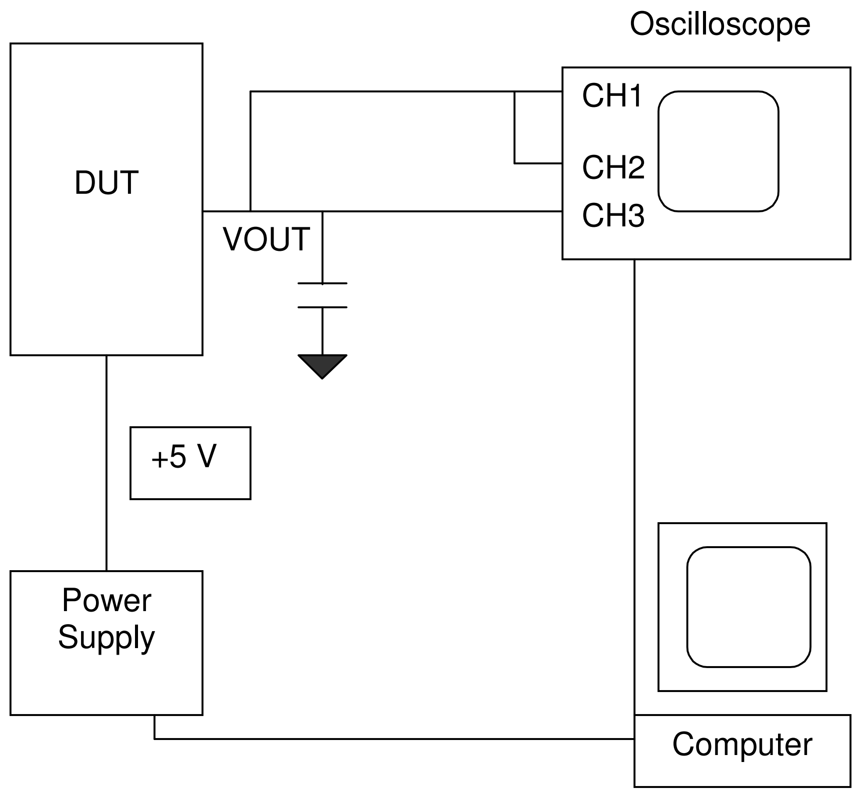

Fig. 3. Block Diagram for testing the MSK5101.

VI. Test Performance

The output of the DUT was connected to two input channels of the oscilloscope to allow triggering on both positive and negative transients. When a transient occured, it triggered the oscilloscope and the data will was captured and transferred to the computer for storage and later analysis. The de-lidded device was mounted in front of the beam and verified functional. Once the irradiation began, we collected a transients until the total reached a minimum of 600 traces for each ion species, or until we reached a preset fluence limit (2E6 ions cm^{-2}). We started irradiating with the Xe and then stepped through Ar, Ne and ended with Kr. Testing was conducte for normally incident ions and for ions incident at 60 degrees to the normal.

VII. Results

Transients were seen even at the lowest test LET of 2.8 $MeVcm^2/mg$. Below LET~4 $MeVcm^2/mg$, only positive-going transients were seen. Transients were small in both magnitude (<0.3 V) and duration (<20 µs). At higher LET, positive-going transients stayed about the same magnitude and increased only slightly in duration, while negative-going transients started to be seen, rising rapidly in both cross section (Figure 1), duration (Figure 2) and Magnitude (Figure 3). No positive-going transients were seen to last longer than ~30 microseconds, while the longest negative transients lasted about 80

microseconds. Positive transients did not exceed about 350 mV, while negative transients with magnitudes up to 1.86 V were seen.
For the orbit of the Hubble Space Telescope, positive transients are unlikely to occur at a rate greater than about 1 every 1000 days per regulator. For negative transients the rate is about once in 200 days.

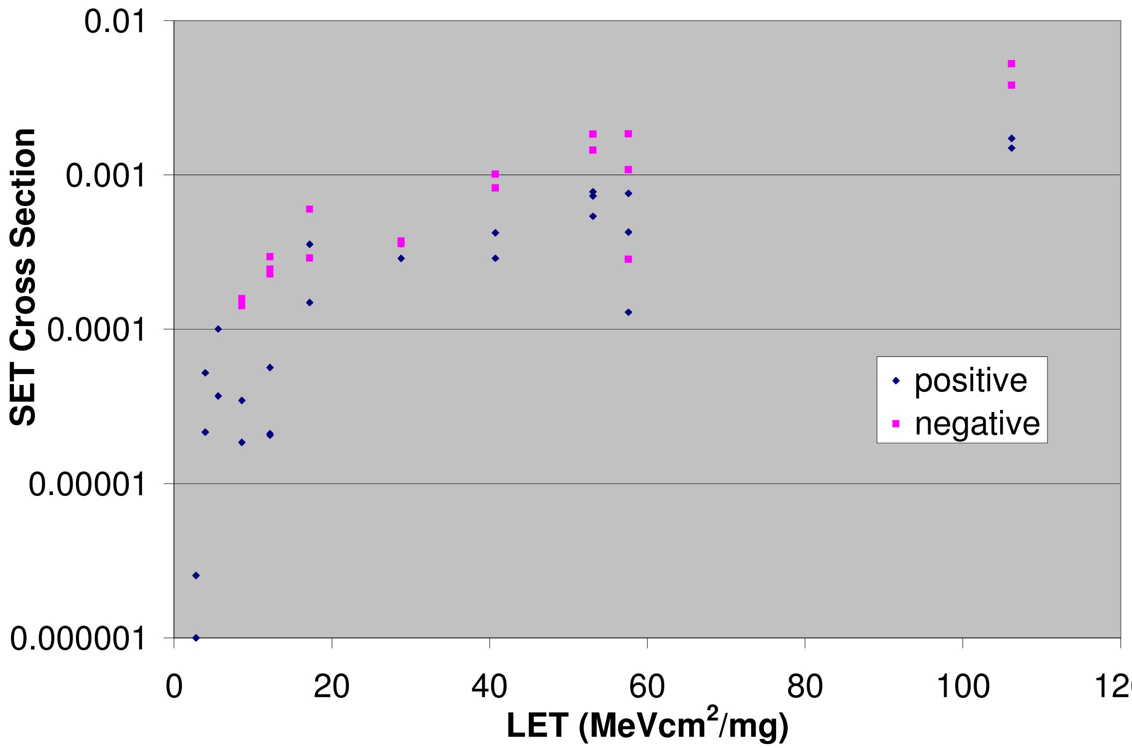

Figure 1 Cross section vs. LET for all positive and negative transients vs. LET.

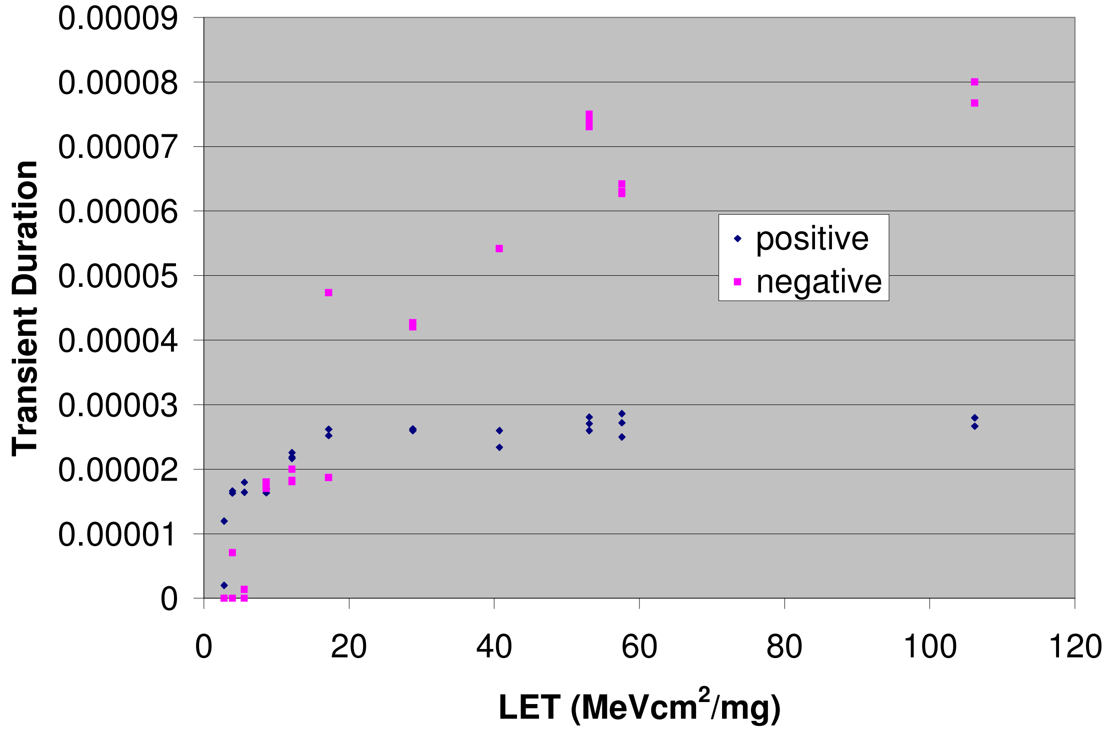

Figure 2 Transient duration vs. LET for positive and negative transients.

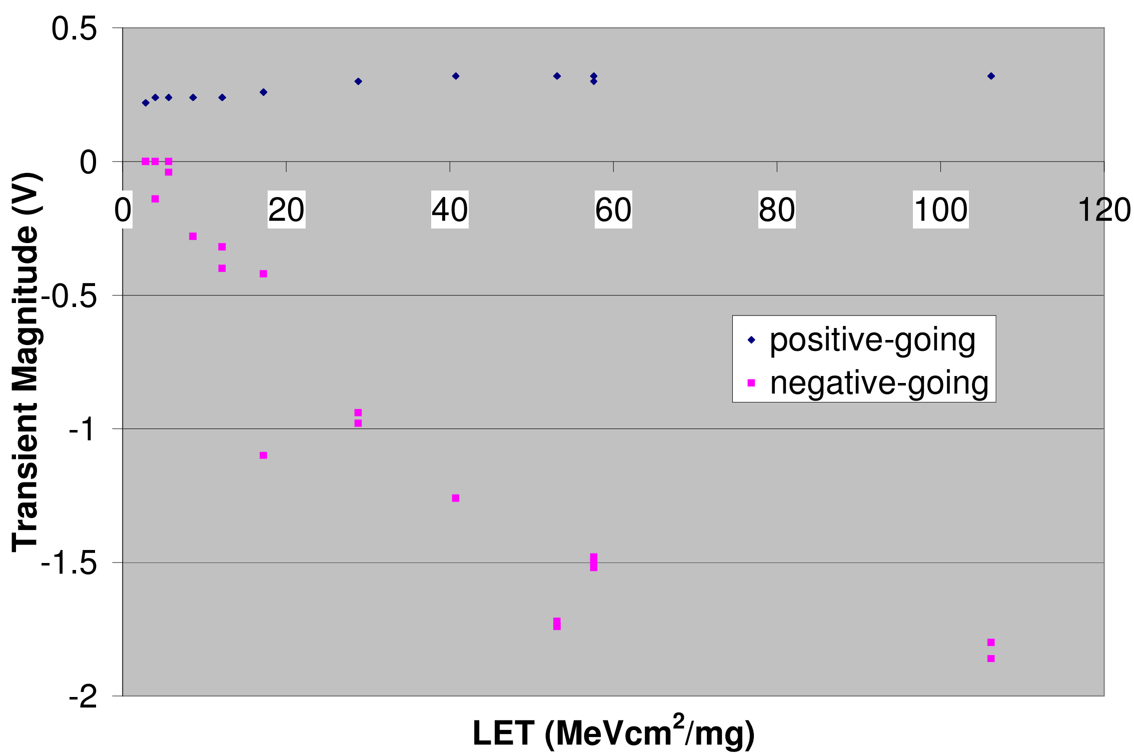

Figure 3 Transient magnitude vs. LET for both positive and negative transients.